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EXAMINATION OF THE SPINAL CORD IN A CASE OF POLIOMYELITIS OF THE ADULT, OF TWO MONTHS' STANDING.

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IT seems to be now almost universally believed that the disease which has become so familiar under the name of poliomyelitis acuta infantum, has its complete analogue among the diseases of the adult spinal cord, but as yet so few autopsies have been recorded in cases of the latter kind, especially such as illustrate the earlier stages of the affection, that no excuse is needed for offering another example here.

Furthermore, it remains to be seen whether in spite of the close likeness between the infantile and the adult form of the disease, there may not be discovered differences between them of sufficient constancy to justify new physiological or pathological generalizations.

Thus, to mention but one point, it appears from the interesting analyses of Franz Müller ("Die acutè Spinallähmung des Erwachsenen," Stuttgart, 1880), that it is far more common in the case of adults than in that of children, for the spinal cord to be affected in its whole length, although the greater longitudinal extension of the lesion by no means implies a greater intensity at any given point. Thus, out of 47 cases of the adult form all four extremities were affected in 22 (or about 47 per cent.), while this happened in only 5 out of 62 cases (or 8 per cent.) of the infantile form.

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No doubt this difference is partly to be explained by the fact that the term acute poliomyelitis has been made to cover a greater variety of pathological states in the case of the infant than in that of the adult. Leyden, for example, has described at least three quite different forms.

Even though the nature of the disease be well understood, moreover, it is important that we should become familiar with all its stages. I am aware that the microscopic appearances, essentially like those that I shall describe, have repeatedly been observed by others, but the number of cases, even in children, which have been studied at two months after the attack, is not great, and, so far as I know, this is the first case of the kind in an adult, that has been recorded.

The patient whose case is the subject of this paper was a young woman of twenty-two, unmarried, who entered the Mass. Gen. Hosp., in August 11, 1880, and remained until her death (Sept. 26), under the care of Dr. B. S. Shaw, with whom I frequently saw her, and who very kindly allowed me to make the examination of the cord.

Her health before this illness had been good, though she had suffered much from the heat, which had been severe.

No cause could be assigned for the attack, which had occurred three weeks before her entrance to the hospital, except that very shortly before it she had got her feet wet while menstruating, as a result of which the menses had ceased.[1]

The first symptoms were said to have been severe pain, in head neck, back, and limbs, and obstinate vomiting, ushered in by a slight chill.

After three days the pain lessened somewhat, but she became rapidly helpless. During the first three days she was unable to pass her urine.

Pain in the shoulders and limbs continued to be a prominent symptom, and she suffered from a wide-spread sense of numbness, prickling, etc., especially in the legs below the knees, and in the right arm.

[1] Some years ago I saw another patient, a woman in perfect health, who after—and presumably as a result of—precisely this same experience, was suddenly seized with paralysis of all four extremities, from an affection of the cervical cord.

At her entrance into the hospital her pulse was 108; temperature, 99.8° (F.); tongue, dry and cracked.

There was marked tenderness along the spine on deep pressure, especially in the dorsal region.

There was more or less atrophy throughout the entire muscular system of the body, but the muscles of the right arm were especially affected, and still more the small muscles of the right hand, which were greatly wasted.

Motion was everywhere impaired, but so much pain was excited by any attempt to move that a thorough examination as to this point was postponed, and no accurate record of it was made.

A few days later, however, it is recorded that no movement of any part of the body was absolutely lost, though from a mixture of pain and weakness she was unable to turn in bed alone, and the right arm was almost helpless.

The motions of the right arm which were most seriously impaired, were abduction at the shoulder, flexion at the elbow, and some of the movements of the fingers. These were in fact almost lost at first. Flexion and extension of the fingers were, however, always possible to some extent.

For the first two weeks, pain in the back, neck, shoulders, and in all four extremities, remained the predominant symptoms. This pain was increased by the slightest motion, whether passive or voluntary, and was a good deal relieved by continuous applications of ice to the spine. The patient lay constantly on the back, and could not bear to have the limbs handled unless with great care. The fingers of the right hand, and the arm at the elbow joint, were kept semi-flexed, and any attempt to extend them fully caused considerable pain, which was referred to the tendons of the muscles which were thus put upon the stretch.

There was also occasional inability to micturate, for a part or the whole of a day at a time.

After a few days the pain began to subside slowly, and at the same time motion began to improve.

There was no high fever, and no motor signs of meningitis beyond the contractures above alluded to, and the fact (probably of no great importance) that the first time she sat up on the edge of the bed she was seized with muscular cramps in both legs.

On Aug. 25th she was reported as gaining daily, and now able to raise the right arm at the shoulder.

Improvement went on in this way so far that the patient was able to sit up, and seemed likely to regain a good deal of the lost

power, when on Sept. 13th the temperature went suddenly up to 102° (F.), and the pulse to 130, though without any symptoms directly referable to the spinal cord, unless some increase of the spinal tenderness and pain, which had been present throughout, be considered as such.

On Aug. 16th she was attacked with persistent vomiting; on the 17th she had two dejections containing a considerable quantity of fluid blood.

The vomiting was so persistent, that an attempt was made to give all nourishment by the rectum, except a little brandy or champagne and ice. Beef tea, or milk, with a little opium, was accordingly administered in this way, and at first some of the injections were retained.

On Sept. 20th, however, she began to have frequent involuntary dejections, many of them bloody, and to reject the enemas. From this moment her strength failed rapidly.

The mouth and fauces became very dry, and sordes collected on the lips and teeth.

There were no cerebral symptoms, except that for a day or two before death she was nearly unconscious, and mildly delirious.

She died on Sept. 26th.

The temperature, through the first three weeks of the patient's illness, ranged regularly from 98.2° (F.) to 98.8° (F.) in the morning, and 99° to 99.4° in the evening.

The pulse varied between 70 and 85.

At the outset of the new symptoms (Sept. 13th), the temperature rose suddenly to 102° (F.) (evening), fell the next morning to 98.2°; then rose and fell once more; and finally rose and oscillated between 100.5° and 102°, until two days before death, from which time it fell steadily, finally reaching 98.4°.

The pulse ranged, with great variations, between 100 and 130.

Her condition was such that it would have been difficult to make a satisfactory investigation of the motor functions during the last week, but nothing was seen which suggested any special change in this respect.

The autopsy was performed thirteen hours after death, and the following were the chief points elicited, as copied from the hospital records:

Thorax.—Pericardium contained 40 c. c. of serous fluid. Left side of heart contracted; right side distended with fluid blood. No disease of valves or heart-tissue.

Inspection of the lungs revealed a large number of dark red spots,

scattered over its surface, varying in size from that of a pin's head to that of a silver dollar. When cut into, these spots proved to be hemorrhages beneath the pleura, extending to various depths into the substance of the lung. They were most numerous over the left lower lobe, but there were many on the right lower lobe; several on the left upper lobe, and a few on the right upper lobe.

Abdomen.—All the abdominal organs were healthy, though congested, except the intestine, and this was normal as far down as to the lower part of the ilium. About a foot above the ileo-cæcal valve, the Peyer's patches were found thickened. Below this point the mucous membrane was the seat of numerous small ulcerations and slight hemorrhages, not confined to Peyer's patches.

Throughout the large intestine the mucous membrane was roughened and there were many deep ulcerations, with patches of false membrane adherent to their surface. Some of these ulcerations extended through almost to the peritoneal coat.

Of the nervous structures the *spinal cord* alone was removed and given to me for examination.

The membranes of the cord presented, to the naked eye, no appearance of disease. Cross-sections, made at short intervals throughout its length, showed its substance to be of about normal consistency. Spots of very slight discoloration were, however, visible here and there throughout.

The specimen was hardened in Müller's fluid, and excellent microscopic preparations were obtained a few months later.

Sections were cut at intervals of about three quarters of an inch throughout the whole cord, stained either with picro-carmine, or hæmatoxyline, or by first the one, then the other, which gave the best results, clarified with oil of cloves, and eventually mounted in Canada balsam.

Certain gross lesions were visible on these sections, even with the naked eye.

At about the middle of each anterior cornu a rarefied spot was seen, of irregular outline, sometimes extending in the direction of the central canal, sometimes toward and into the posterior cornu.

In fact the posterior cornu was often involved in its entire length, and the spot of rarefied tissue there appeared in some sections to be separated by a bridge of relatively healthy tissue from the spot in the anterior cornu. In other words, the central portions of the posterior columns had suffered the most severely.

The lesion in the two sides was symmetrical, but the right side was the more severely affected.

The gray matter of the spinal cord was thus threaded in its whole length by these columns of inflamed tissue.

Unfortuately the medulla oblongata had not been removed ; but as the disease was well marked at the upper end of the cervical region, it is not improbable that it extended higher, and perhaps furnished the cause of the subpleural hemorrhages, and indirectly of the patient's death.

The lumbar region was less severely affected than either the cervical or dorsal.

When these sections were examined under a low power it was seen that throughout the most inflamed portions, the ganglion cells were, as a rule, either absent, or represented by pale, rounded bodies, without processes. This was especially true of the right anterior cornu, where in many sections no ganglion cells at all, or only a few degenerated remains, were visible. In the left anterior cornu there were always a greater or less number of ganglion cells present, though often but few or none that were not more or less diseased.

The *groups* of cells in the cervical and dorsal regions, which were relatively well preserved, were the antero-lateral and postero-lateral (Ross) groups in the lower cervical and upper dorsal regions, and a small group seen in a few sections in the dorsal region, a little external to the columns of Clarke.

In the lumbar region, all the great peripheral groups of cells were in a pretty good state of preservation, the inflammation being less severe than in the dorsal and cervical regions, and more nearly confined to the median area of the anterior cornu. The posterior columns, nevertheless, had not escaped their due share of the lesions.

The columns of Clarke themselves, likewise, though by no means unaffected, had been much more spared than most of the rest.

I was unable to verify the statement made by Ross with regard to a more chronic class of cases, namely, that the peripheral (" accessory ") cells of the special groups were most affected. As a rule, the degree to which the cells were atrophied depended on their position with regard to the centre of inflammation.

This rule was not invariable, however, and it was sometimes striking to see a fairly well-preserved cell lying close to the inflamed area, and sending its processes, usually pale, and swollen or granular, to be sure, through the midst of the disintegrated tissue.

Even some of the small cells of the "median area" (Ross) were often quite well preserved; and these facts seem to make it clear that this inflammatory process is not one that affects ganglion cells materially more than other tissues in their neighborhood.

The vessels, as seen also with a low power, were deeply congested in the inflamed parts, and indeed throughout the gray matter, and their sheaths often crowded with lymphoid cells. The walls of most of the small arteries of the whole cord appeared thickened.

The exudation of lymphoid cells from a given artery into the surrounding tissue, was by no means proportionate at every point to the degree to which the vascular sheath was filled with them, but seemed to have occurred here and there, forming foci of infiltration.

The central canal was usually blocked with cells, and in some places had lost its form and structure altogether, appearing only as a mass of cells and (under a higher power) a net-work of hair-like fibres, which could be traced to the protoplasm of cells of irregular shape, with which the peri-ependymal tissue was richly supplied.

Although the *acutest* inflammation had been confined to the gray matter, other changes of hardly less interest were observable, even with low powers, in other parts of the cord.

Thus, in many of the preparations, the antero-lateral columns appeared to be peppered with minute spaces of circular shape, in many of which subsequent examination showed the presence of shrunken cells (granular cells ?) with or without nuclei.

There was, in fact, no part of the section which did not exhibit more or less characteristic lesions.

There was a pretty general increase of connective tissue, originating: (1) in a dense overgrowth of the tissue entering with some of the anterior, and to a less degree, of the posterior nerve-roots; (2) in the hypertrophied trabeculæ coming from the pia mater; (3) in the tissue surrounding the thickened vessels; (4) in the trabeculæ running out from the framework of the anterior gray matter; (5) in interstitial growth of fibres from Deiters' cells, and from the protoplasm surrounding the free nuclei.

The parts which were the most free from this overgrowth of connective tissue were: the anterior half of the posterior columns in the cervical region, and the posterior and peripheral portions of the lateral columns, except near the posterior nerve-roots.

The parts most diseased were: the whole segment through

which the anterior nerve-roots pass, the region of the anterior pyramid-tract, and portions of the lateral columns.

When examined with higher powers there were evidences of disease, even within the limits indicated, in the form of atrophy and moderate hypertrophy of axis-cylinders, in various degrees.

The minute globular spaces, above referred to as often containing one or more shrunken cells, which were evidently the remains of granular bodies, were seen on several sections in both the anterior and posterior roots, even beyond the limits of the cord.

Such portions of the *nerve-roots* as happened to come within the limits of the sections were all more or less diseased,—the anterior much more than the posterior,—though all contained a certain number of axis-cylinders still capable of taking up coloring matter to some extent.

Occasionally an axis-cylinder was seen in them, which appeared to be increased in size, but this increase was not great, and the outline of such fibres was for the most part nearly uniform. The great majority of the fibres of the anterior roots were very narrow and pale, and the number was much diminished.

The use of the higher powers disclosed also other facts of histological interest.

The degeneration of the *ganglion cells* could be plainly seen in several stages.

Among the slighter changes, *i. e.*, while the cell still absorbed carmine freely, and looked fairly normal in structure—was an alteration in the shape of the nucleus, which had become shrunken and irregular in outline, and had apparently lost its nucleolus. Other cells, which also absorbed carmine, had a mottled, mulberry-like surface, suggestive of "cloudy swelling."

Those nearest the centre of inflammation were always pale, sometimes excessively so, and had often lost their processes, and become almost indistinguishable. A considerable degree of paleness, however, was not incompatible with the possession of a regularly globular nucleus, and a nucleolus.

Vacuoles in the ganglion cells were observed only once or twice.

The cells of the posterior cornua were less noticeably diseased, but some of them also were pale, indistinct, and granular.

In spite of the diseased appearance of the majority of the remaining ganglion cells, the great amelioration which had taken place in the patient's condition suggests that they may have been capable of functioning to some extent, and this suspicion is in-

creased when we reflect that two months had elapsed, by which time those which were destined to atrophy and shrink, as had happened with some of them, or to be disintegrated, would probably have undergone this change already, and that many of the appearances actually observed were re-gressive in their nature.

Some of the nerve-fibres may also have been newly formed, but it is not certain that the enlargement of the axis-cylinders is incompatible with a power of conduction.

The *vessels* were everywhere thickened, as has been said, and were often the centre of an island of hypertrophied connective tissue, or of a spot of rarefied substance, dotted with minute points (granular degeneration ?).

One or two small arteries were seen with collections of shining pigment in their walls, grouped like longitudinal nuclei.

Special interest attaches to the study of the origin of the fine non-nervous filaments, with which almost every part of the section was penetrated.

In the areas of acute inflammation, the true spider cells, with their pale, irregular, and homogeneous bodies, were very abundant, and the fact that they were, at this stage of the disease (two months from the outset), so large and numerous, lends support to Leyden's view, that they have in some way to do with the processes of absorption and repair rather than with that of inflammation (*vid.* a summary of views on this point, by Dr. S. G. Webber, in the Med. and Surg. Reps. of the Boston City Hosp., 3d ser.).

Another observation of Leyden's (Klinik d. R. markskrankh., vol. 1) is pertinent in this connection. It is that a true increase of connective-tissue elements occurs less often and to a less degree than is usually assumed, a good part of the appearances laid to the door of the multiplication of cells being really due to a hypertrophic growth of pre-existing fibres.

Certainly, in this case, neither the increase in the number of the spider cells, nor of the free nuclei or connective-tissue cells seemed great enough to account for the mass of fine fibres to which (presumably) the coarsely granular appearance of the interstitial substance everywhere was due, unless we assume a still greater increase in the length and thickness and number of the hair-like cell-processes.

Some of the finest of these processes evidently arose from the delicate protoplasm surrounding the free nuclei of the neuroglia.

The lymphoid elements from the vessels appeared also to be

taking part in the processes which were going on, inasmuch as they also could be seen to be enveloped in a small quantity of homogeneous protoplasm, with definite outline.

An appearance was also seen which may have indicated a process of division of these growing cells into two, or may have been due merely to the mutual pressure of two adjacent cells. This was a sharp line of demarcation between two cell-bodies, the line sometimes widening into an actual interval.

The globular spaces containing shrunken cells were best seen on longitudinal sections, where they had been formed one above another, between the longitudinal bundles of fibres in the antero-lateral columns. The nuclei of the cells lying in these spaces could sometimes be colored with hæmatoxyline, and this circumstance, coupled with the fact that the cell-bodies were occasionally not shrunken, but pale and homogeneous or granular, led me to think that these cells had resulted from the overgrowth and degeneration of the protoplasmic masses surrounding the free nuclei of the neuroglia.

Similar cells were seen, though rarely, in the inflamed portion of the gray matter. The position in which they were generally found suggested that their development was associated with the destruction of medullated nerve-fibres, as is usually assumed.

In the white columns the condition of the parts was not everywhere the same. Throughout the antero-lateral tract, besides the increase in the connective tissue, and the vacuole-formation, there were signs of both atrophy and moderate hypertrophy of the axis-cylinders, and the same was true of the anterior and lateral portions of the posterior columns in the cervical region.

In the posterior portions of the posterior columns, especially the columns of Goll, there was increase of connective tissue, and a moderate degree of degeneration of the nerve-fibres, chiefly shown by changes in the condition of the myeline.

The bits of *pia mater* which adhered to the cord near the posterior nerve-roots bore marks of moderate thickening, and more or less cellular infiltration.

To sum up the facts of this case: We have here a healthy patient, seized, after an exposure during menstruation, with vomiting and persistent pain, and immediately afterward with wide-spread atrophy and loss of muscular power, these latter symptoms affecting the right arm and hand very much more than any other part of the body.

After six weeks the patient is seized anew with vomiting, and with dysenteric symptoms, loses control of the sphincters, has a very rapid pulse, with considerable fever, and dies with symptoms of prostration after two weeks.

On post-mortem examination there are found: extensive ulcerations in the large intestine; sub-pleural hemorrhages: poliomyelitis anterior and posterior throughout the whole length of the cord, centring in the median area of the anterior cornu, involving the right side much more than the left (in the cervical and dorsal regions); also atrophy of the anterior nerve-roots, and to some extent the posterior; sub-acute inflammation of the antero-lateral white columns; a moderate amount of lepto-meningitis; thickening of vessels everywhere, even in the posterior columns; and diffused, though moderate, increase of the connective tissue.

The signs of connective-tissue change were, in fact, so widespread, that the term poliomyelitis should probably be exchanged for that of diffused myelitis, as in Schultze's very similar case; and it is possible that the original morbid change was one affecting the vessels and the circulation; and that the median area of the anterior cornu suffered so severely, only because especially prone to become inflamed.

The clinical record is not sufficiently minute to justify definite conclusions as to the origin of the symptoms which resulted in the patient's death.

The last illness was evidently no ordinary dysentery, or typhoid.

The sub-pleural hemorrhages suggest the possibility of an extension of the disease of the cord into the medulla oblongata.

There is, however, little reason to doubt that the majority of the lesions found within the cord were those attributable to the first attack.

It is possible that the injections of food, acting upon

membranes of reduced vitality, had something to do with the ulcerations in the large intestine.

The symptoms cannot have entirely originated in this way, however, since the persistent vomiting and the first bloody dejections and the high temperature antedated the use of the enemata.

The greater amount of disease in the right anterior cornu of the cervical region perfectly explains the greater degree of atrophy in the right arm; but it is doubtful whether it would have been possible to discover the lesions corresponding to the affection of particular muscles, even had the clinical history been more complete, since all the groups of cells on the right side were so severely involved.

The groups of cells most affected, however, were those of the "median area," and both the anterior groups; while those best preserved were the extreme lateral and posterior groups.

The movements most seriously impaired were abduction at the shoulder, flexion at the elbow, and the finer movements of the fingers.